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1	1	Cog. Mgr. R.A. Carlson/R.P. Henckel	RA Carlson	3/11/93	H6-02						
1	1	QA T.L. Bennington	[signature] for	3/15/93	H4-16						
1	1	Safety K. A. Smith	M Beum for KA Smith	3/11/93	N1-06						
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7. Abstract

This safety assessment addresses the installation, development, sampling, remediation, and abandonment of groundwater monitoring wells and accesses the adequacy of existing work procedures.

9. Impact Level 2 ESQ

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FIGURES:

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LIST OF TERMS

ALARA	as low as reasonably achievable
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
DOE	U.S. Department of Energy
EII	Environmental Investigations Instructions
EPA	U.S. Environmental Protection Agency
HWOP	Hazardous Waste Operations Permit
IDLH	immediately dangerous to life and health
JSA	Job Safety Analysis
LEL	lower explosive limit
MCL	maximum contaminate levels
RCRA	Resource Conservation and Recovery Act
RL	U.S. Department of Energy, Richland Field Office
RWP	Radiation Work Permit
TWA	time weighted average
WHC	Westinghouse Hanford Company

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1.0 INTRODUCTION AND SUMMARY

Westinghouse Hanford Company (WHC) is responsible for managing the installation and operation of Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response Compensation and Liability Act (CERCLA) groundwater monitoring wells for the U.S. Department of Energy (DOE). Groundwater monitoring wells are installed to assist in characterizing the subsurface hydrogeologic conditions, the nature and extent of contaminant migration to groundwater, and to monitor changes in groundwater conditions. Information obtained from these activities will be used in deciding the appropriate actions necessary to achieve the desired cleanup goals.

The RCRA wells are typically installed near a facility for the purpose of detecting contaminants in the groundwater that may be migrating from that facility. These wells are installed in areas where the groundwater should be relatively free of contamination. The CERCLA wells, however, are installed in suspected groundwater contaminant plumes for monitoring changes in the contaminant concentrations. The exception to this scenario is the CERCLA wells that are drilled upgradient of the suspected contaminant area to determine the chemistry of the groundwater before contacting contaminated sediments. In both the RCRA and CERCLA groundwater well installations, efforts are made to drill where there is no surface or subsurface contamination present.

This document provides a safety assessment of groundwater monitoring wells at the Hanford Site. Groundwater monitoring wells installed in areas that meet the release criteria (Section 11 of WHC-CM-4-10, *Radiation Protection Manual*) are excluded from the safety analysis requirements in DOE 1986. Groundwater wells in areas contaminated above the release criteria are subject to the controls and prudent actions of this assessment.

The installation and operation of the subject groundwater wells represent only minimal worker health risks from radiological or toxic chemical substances. The groundwater well installations and operations are low hazard activities as defined by DOE 1986. This assessment complies with the policy requirements in WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual*, and procedures in WHC-CM-6-32, *Safety Analysis and Regulation Work Procedures* for low hazard environmental restoration activities. Controls and prudent actions provided in Section 5.0 of this assessment will be implemented through Radiation Work Permits (RWP), Hazardous Waste Operation Plans (HWOP), and other appropriate job specific controls.

The activities covered in this assessment include the installation, development, sampling, remediation and abandonment of groundwater monitoring wells. The hazards and risks involved in these activities are considered well below the risk acceptance criteria provided in WHC-CM-4-46.

Two operational safety limits (OSL) were prepared to ensure the integrity of the safety basis of this assessment. The first OSL sets a limit of 10 mR/hour on the drill cuttings at wells drilled or remediated in areas where the criteria of WHC-CM-4-10 (Section 11) is exceeded. The second OSL limits spark producing activities when combustible gas levels >10% of the lower explosive limit (LEL) are detected in the borehole.

Purgewater removed from wells in certain locations at the Hanford Site (e.g., downgradient from a liquid waste disposal site) may contain contaminants at levels above water quality standards but in most cases contaminant concentrations are below detection levels. The document *Strategy for Handling And Disposing Of Purgewater at the Hanford Site, Washington* (DOE-RL 1990) contains collection criteria that provide an acceptable level of protection to public health and the environment. Table 4 in DOE-RL 1990 contains an updated listing of Hanford Site wells requiring purgewater collection.

2.0 WORK DESCRIPTION

The current regulatory approach to the Hanford Site cleanup is defined by the *Hanford Federal Facility Agreement and Consent Order*, referred to as the Tri-Party Agreement, issued in May 1989 (Ecology et al. 1990). The approach described in the Tri-Party Agreement directs cleanup by operable unit (groups of sites) of which over 78 have been identified at the Hanford Site. These operable units are allocated within aggregate areas (operational areas established in the 1940's). The aggregate areas include the 100, 200, 300, 600, and 1100 Areas.

The scope of this assessment covers the drilling of RCRA and CERCLA groundwater monitoring wells and associated activities in areas that do not meet the criteria specified in WHC-CM-4-10 (Section 11). As discussed in Section 1.0, most RCRA wells are installed at sites that are free of contamination as determined by examining analytical data from other monitoring wells in the vicinity, and would therefore be excluded from the safety review requirements of DOE 1986.

2.1 CONTAMINANTS OF CONCERN

Soil sampling data is limited for the Hanford Site, but it can be assumed that the contaminants found in groundwater may also be present in the soils. The specific contaminants of concern will vary depending on the areas where groundwater monitoring wells are installed.

A wide variety of contaminants are known to exist in the 100 Areas. Chromium has been found in groundwater from wells in the 100-B, 100-D, 100-H, and 100-K Areas. One well in the 100-F Area showed detectable hexavalent chromium. Tritium is present in many waste streams discharged to the soil at the 100-D Area. Tritium concentrations greater than the 20,000 pCi/L maximum contamination level (MCL) have been detected in portions of the 100-B, 100-D, 100-K, and 100-N Areas. Concentrations of strontium-90 (^{90}Sr) have been detected above the 8 pCi/l MCL in wells in the 100-B, 100-D, 100-F, 100-K, and 100-N Areas. Concentrations of technetium-99 (^{99}Tc) greater than the 900 pCi/L MCL have been detected in wells at the 100-H Area. A uranium plume also exists in the 100-H Area near the 183-H Solar Evaporation Basins. Nitrate has been detected above 45 p/m in wells at the 100-B, 100-D, 100-H, 100-K, and 100-N Areas.

Operational activities in the 200 Areas have resulted in significant levels of contamination due to the discharge of steam and process condensates and process cooling waters to the soil column for disposal. Additional soil contamination has resulted from tank farm operations and solid waste burial practices. The primary contaminants of concern in the 200 Area soils and groundwater include mixed fission and activation products [cobalt-60 (^{60}Co), cesium-137 (^{137}Cs), ^{90}Sr, and ^{99}Tc], nonmetallic ions (cyanide, nitrate, fluoride), heavy metals (chromium), and organics [carbon tetrachloride (CCl_4) and trichloroethylene]. Tritium concentrations greater than the 20,000 pCi/L MCL were detected in portions of the 200 East, 200 West, and 600 Areas. The CCl_4 and chloroform (a degradation product of CCl_4) plumes exist beneath the central and northern parts of the 200 West Area.

The primary contaminants of concern in the 300 Area are heavy metals including uranium. Additional contaminants of concern include trichloroethylene, fluoride, and 1,2-dichloroethylene. A plume of uranium contaminated groundwater exists in the unconfined aquifer beneath the 300 Area in the vicinity of the uranium fuel fabrication facilities and inactive waste sites known to have received uranium waste.

The 600 Area is land at the Hanford Site not included in either the 100, 200, 300, 400, or 1100 Areas. Cyanide has been detected in groundwater samples from wells in the 600 Area directly north of the 200 East Area. Wells containing cyanide also contain concentrations of several radionuclides including ^{60}Co. Chromium has been found in various wells in the 600 Area, particularly near the 100-D and 100-H Areas. Elevated tritium concentrations have been measured in several 600 Area wells downgradient from the 200 East Area. Iodine-129 has been detected in groundwater monitoring wells in the 600 Area. The highest concentrations have been found in a well located just outside the 200 West Area boundary and downgradient from the Reduction Oxidation Plant.

The purpose for installing groundwater monitoring wells is to characterize subsurface hydrogeology and determine the extent or existence of groundwater contamination. This is in contrast to the purpose for drilling characterization boreholes in or near waste disposal sites to determine the downward migration of contaminants through the vadose zone. Consequently, sites planned for groundwater well installations typically have very little contamination present in the vadose zone. Where contamination has been encountered in past groundwater well drilling activities, maximum levels have generally been <10,000 dpm beta/gamma per probe area. Contamination at these levels is easily controlled and presents only a minor hazard or as low as reasonably achievable (ALARA) concern to the site worker.

Groundwater monitoring well installation activities are classed as either low, moderate, or high risk depending on the potential for encountering radiological and/or chemical contamination. The level of risk determines the level of controls to be administered; for example, an a.m./p.m. survey is generally conducted for low risk wells while continuous coverage would be required for high risk wells. High risk refers to drilling into known contaminated soils.

The drilling phase of groundwater well installations presents the greatest potential for encountering and spreading low level contamination as a result of removing drill cuttings from the borehole. Development and sampling activities are not likely to encounter contamination other than what may exist in the groundwater. Because of the relatively low concentrations of groundwater contaminants, the inherent hazard to the site worker can be considered a minor or ALARA issue. In areas where CCl_4 is the major groundwater contaminant, precautions (contained in the HWOP) are necessary to assure that worker exposure to harmful vapors is ALARA. The disposition of purgewater and its handling has been adequately addressed in DOE-RL 1990.

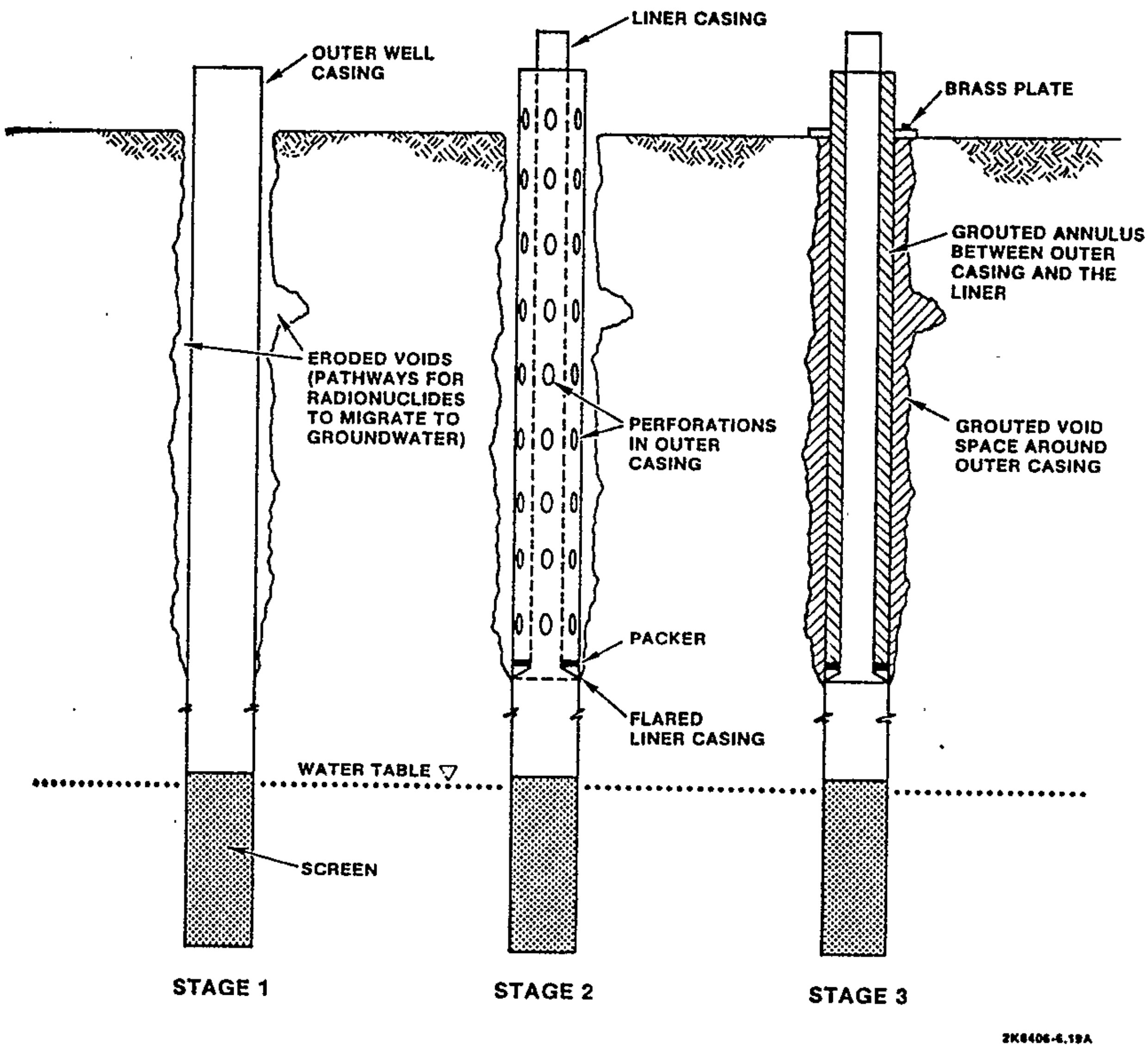
2.2 WELL CONSTRUCTION

Monitoring wells are normally 10.16 cm (4 in.) in diameter. Most of the wells in the groundwater monitoring network are constructed of carbon-steel casing. Current construction requirements employ stainless steel for the final casing. An essential feature in well construction is the use of material (either bentonite or cement) to seal the annular space between the well casing and the soil to prevent the migration of contaminants down the outside of the well casing.

The construction method using carbon-steel casing is often referred to as the "old" method; this method was also used for the renovation of older wells that were not sealed when constructed. The majority of older wells are simply perforated carbon steel casing without liners or packers and grout annulus. The construction process can be discussed in three stages (Figure 1). Stage 1 shows the emplacement of the outer casing of the well from the ground surface to the desired depth. This stage also represents an older well that was not sealed when constructed. Stage 2 involves perforation of the outer casing and emplacement of a smaller diameter liner casing inside the outer casing. The bottom end of the liner casing is inside the outer casing. The bottom end of the liner casing contains a packer, and is flared to be flush with the outer casing to reduce the chance of pumps or downhole tools catching on the lip during removal from the well. In the last process, stage 3, the well is grouted in the annular space between the liner casing and outer casing that also flows through the perforations to seal the outside of the casing against vertical migration of contaminants.

The current method of well construction uses a stainless steel casing involving a pullback of the starter and downsized carbon steel casing. Three stages are also used in this technique. In stage 1, two casings are emplaced: a starter casing of carbon steel to a depth of $\leq$6.1 m (20 ft) with a carbon steel well casing having a smaller diameter is placed inside and extending to approximately 51.8 m (170 ft). The third downsizing usually goes to the desired depth. Completions in the confined aquifer or perched water conditions may require additional downsizing. Stage 2 involves emplacement of a stainless steel casing with a screen at the bottom inside the other two casings; this is the only casing that is left in place. The carbon steel well casing is back pulled from the boring as the filter pack and annular seal materials are placed. Typical unconfined aquifer completions have the top of a 6.1 m (20 ft) screen placed 1.6 m (5 ft) above the water table. The filter pack is placed (only partially developed) to a height of 1 m (3 ft) above the top of the screen. Approximately 1 m (3 ft) to 1.6 m (5 ft) of bentonite pellets are emplaced and then followed by granular bentonite to a depth of approximately 3 m (10 ft) below ground surface. Cement grout is then placed on top of the granular bentonite in the upper 3 m (10 ft) of the well. Figures 2 and 3 depict typical well construction. Detailed current completion requirements are provided in WHC 1992.

Figure 1. Idealized Cross-Sectional Views Depicting Well Construction ("Old" Method).



9 3 1 2 7 7 0 1 3 2 9

Figure 2. Schematic Drawing of a Typical Shallow Groundwater Monitoring Well Completion.

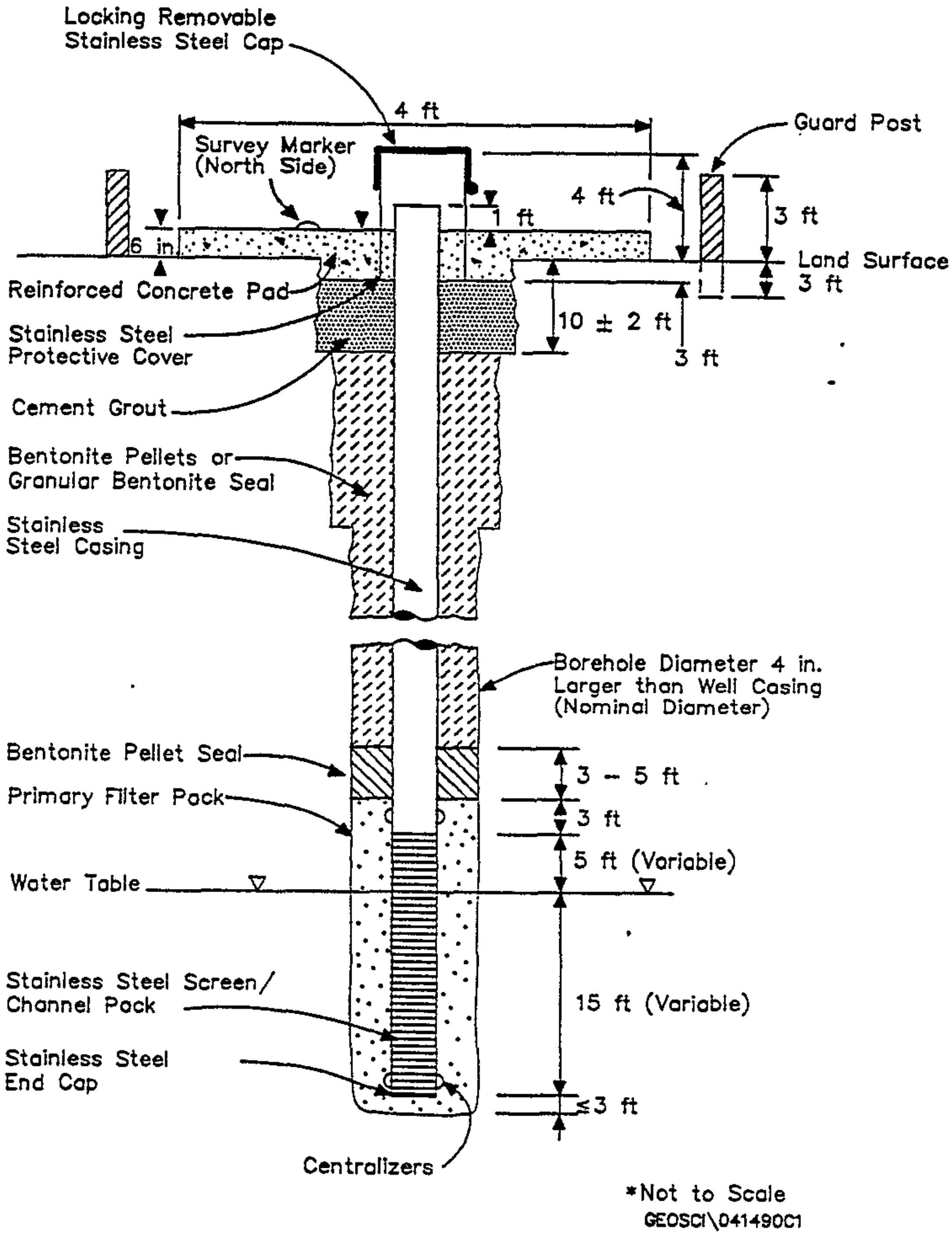
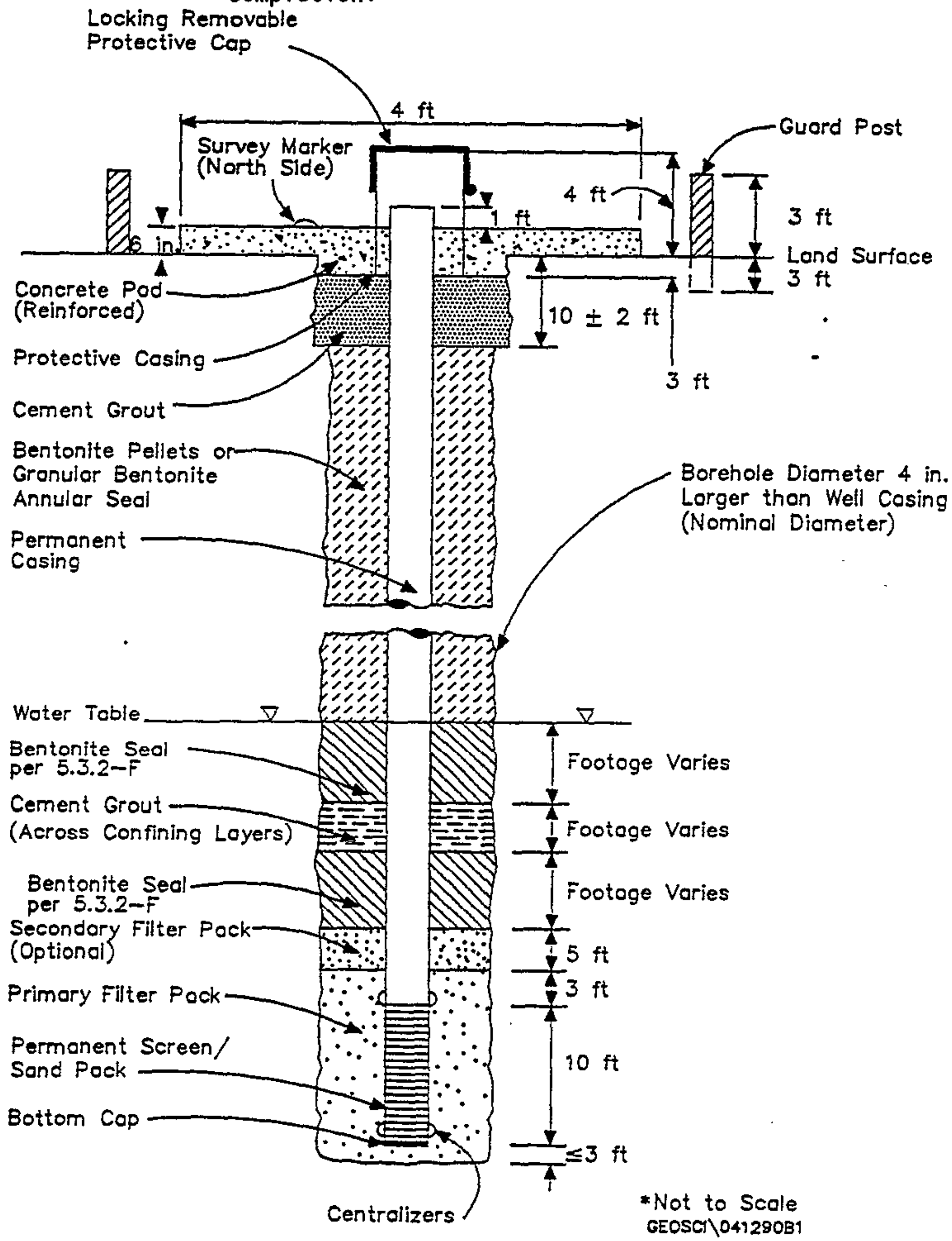


Figure 3. Schematic Drawing of a Typical Deep Groundwater Monitoring Well Completion.



For both construction methods, the wells are fitted with a cement collar at the ground surface and the well designation is painted on. Monitoring wells with dedicated sampling pumps are pumped to remove stagnant water from the well before a sample is collected (Figure 4). Figure 4 depicts a submersible pump; although the pump is still in use at some locations, the current methodology employs a Hydro Star[1] (HS 8000 or HS 8001) positive displacement reciprocating cylinder pump. Wells that do not produce enough water to support a pump are sampled by bailing.

The installation, development, sampling, remediation and abandonment of groundwater monitoring wells is governed by the procedures set forth in WHC-CM-7-7, *Environmental Investigations and Site Characterizations Manual*. Table 1 lists the various activities and corresponding Environmental Investigations Instruction (EII).

Table 1. Groundwater Monitoring Activities and Corresponding Environmental Investigations Instructions.

Interim control of unknown, suspected hazardous and mixed waste	EII 4.2
Control of CERCLA and other past-practice investigation derived waste	EII 4.3
Control and storage of radioactive materials and equipment	EII 4.4
Soil and sediment sampling	EII 5.2
Field decontamination of drilling, well development and sampling equipment	EII 5.4
Groundwater sampling	EII 5.8
Sample packaging and shipping	EII 5.11
Resource protection well services	EII 6.4
Resource protection well characterization and evaluation	EII 6.6
Resource protection well and test borehole drilling	EII 6.7
Well completion	EII 6.8
Abandoning/decommissioning groundwater wells	EII 6.10
Remediation of groundwater wells	EII 8.3
Aquifer testing	EII 10.1
Purgewater management	EII 10.3
Well development activities	EII 10.4

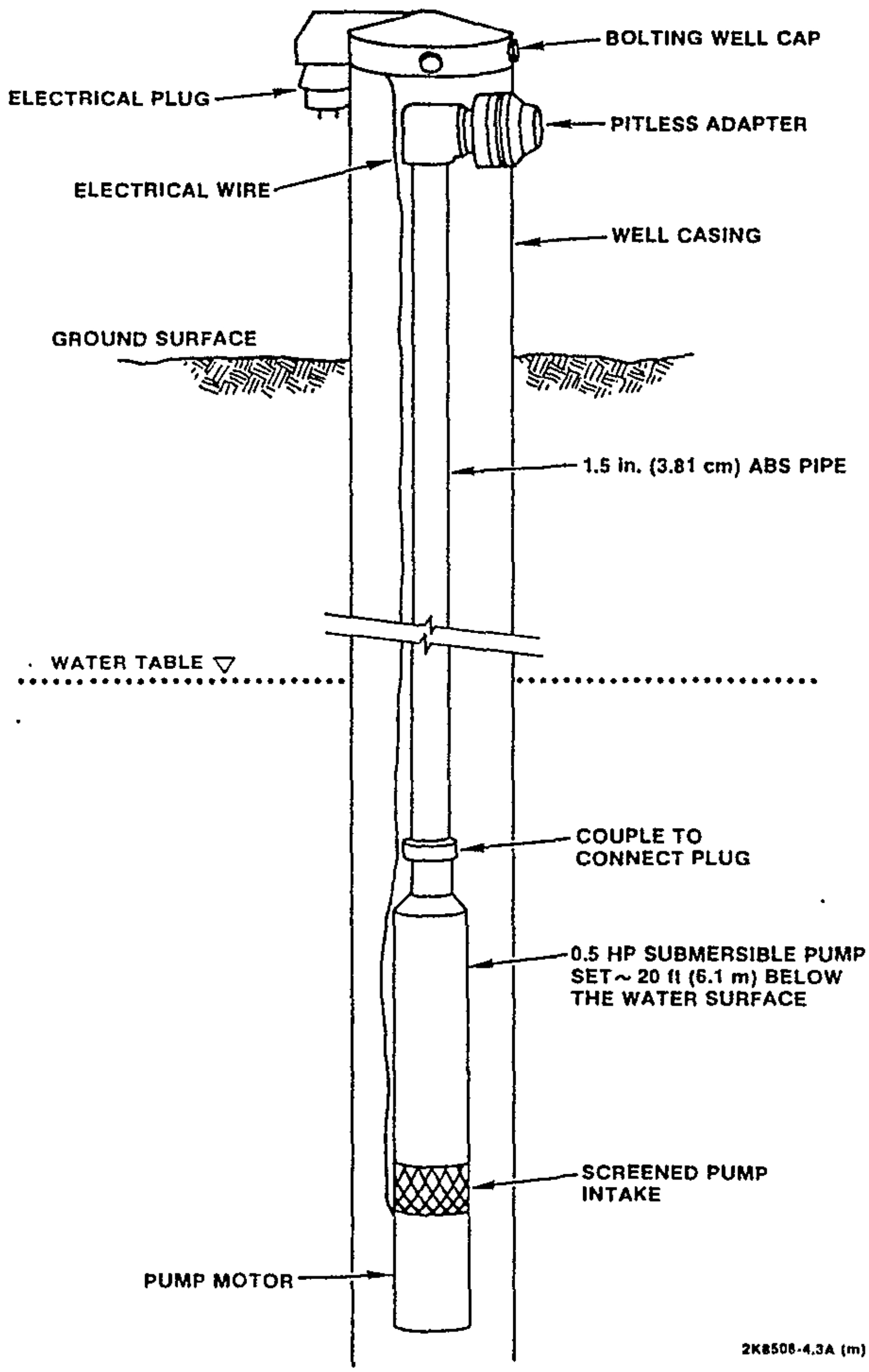
Source: WHC-CM-7-7

2.3 CABLE TOOL DRILLING

The generalized steps used to drill wells and boreholes with a cable tool (percussive) drilling rig are provided in WHC-CM-7-7 (EII 6.7, Appendix A). Cable tool drilling is a method in which the drilling tools are pounded into the soil to advance the borehole to a desired depth. Two techniques are used to advance the hole dependent upon the lithology of the soil. Hard tool drilling uses a drill string that consists of a drill bit, a drill stem, drill jars (used whenever a bit may become stuck or anytime a

[1]Hydro Star is a registered trademark of Instrumentation Northwest Incorporated.

Figure 4. Cross-Section View of a Groundwater Monitoring Well with Pump.



split spoon sample is being taken) and a swivel socket that connects the drill string to the cable. The drill string is driven into the soil by dropping the drill string (1,250 lbs per hard tool and 750 lbs drive/sample barrel as determined by boring diameter and soil conditions) a distance of 60 to 71 cm (24 to 28 in.) approximately 50 times per minute.

Downhole materials are broken up by the pounding action of the bit and then retrieved from the hole with a bailer. The casing is then advanced by percussion to maintain borehole integrity.

When drilling through large gravels and cobbles, hard tool drilling is the preferred method. An alternative method for drilling and retrieving cuttings from the borehole is the drive barrel technique in which a drive barrel is attached to the cable and pounded into the soil, thereby filling and compacting the barrel with soil. The borehole is advanced and cuttings are retrieved intact, inside the drive barrel. The casing is then advanced by percussion to maintain borehole integrity. The drive barrel technique is preferred for drilling in sands and allows for a more accurate assessment of the materials as they are not broken by the abrasive action of the bit.

All equipment and soils that are brought out of the boreholes will be monitored by the monitoring support organization, per the requirements of the RWP and the HWOP using Hanford Site standard field instruments. These field instruments, in conjunction with lithology, drill plan depth, and contaminant concentration are used to determine the point where the size of the casing in the borehole is reduced.

Drill cuttings from the saturated zone or any perched water zones are contained in a drum as required by WHC-CM-7-7 (EII 4.2) until identified for hazardous or nonhazardous classification. Dry cuttings are monitored with field instrumentation and contained only if contamination is indicated.

2.4 SONIC DRILLING

The generalized steps used to drill wells and boreholes with a sonic drill rig are provided in WHC-CM-7-7 (EII 6.7, Appendix D). Sonic drilling is a technology that relies on establishing resonance within the drill string through means of a sonic hammer. The bit consists of relatively large diameter hardened steel with tungsten carbide inserts. Drilling is accomplished by means of a sonic head located on the drilling derrick. This sonic head produces a frequency close to the natural frequency (approximately 70-150 Hz) of the drill column allowing the drill string to act as a flywheel transferring the entire energy of the drill string in bursts to the bit. Drill cuttings are displaced into the annular space or into the core barrel with the core. The hazard associated with low level contamination in the drill cuttings would not be any greater with sonic drilling than with cable tool drilling and is therefore considered negligible.

All equipment and soils that are brought out of the boreholes will be monitored by the monitoring support organization, per the requirements of the RWP and the HWOP, using Hanford Site standard field instruments.

2.5 ODEX DRILLING

The Odex[2] method of drilling uses a top-drive rotary drilling rig in combination with a down-hole percussion hammer equipped with a special bit and eccentric swing-out under-reamer to drill the hole. This method drills and advances a casing string simultaneously, thus maintaining the integrity of the well bore and controlling sample representativeness.

The method uses compressed air that powers a down-hole percussion hammer and provides circulation media to remove cuttings from the drill bit face. The air flow is "direct circulation" where air flows down the center of the drill pipe or string to the hammer and returns through the annular space between the casing and the drill string. Air stream velocity in the annular space is in excess of 914 m/min (3,000 ft/min), providing the lifting capacity necessary for removal of drill cuttings as they are continuously cleared away from the bit face. This action eliminates excessive heating and extends bit life. The high annular velocities result in insignificant lag times between the displacement of cuttings at the bit face by the drilling action and their arrival at the surface. This feature provides for excellent sample correlation to the drilled depth.

Cuttings and any potential contaminants from the drilling process are controlled at the surface by a diverter or discharge head that routes the cuttings through flexible hosing to a cyclone separator and then to a dust control system. Coarse fragments drop out of the air stream by centrifugal action in the cyclone and are captured in drums or ideally, in tote bins. The finer, dust size portion of the cuttings is carried in the air stream to a cartridge dust collection system that further reduces the exhaust stream load. Finally, the airstream passes through a high-efficiency Particulate Air filter followed by atmospheric discharge.

2.6 WELL DEVELOPMENT

The procedure for conducting and documenting activities associated with well development on the Hanford Site are provided in WHC-CM-7-7 (EII 10.4). Well development has two main objectives: (1) to repair damage done to the formation by the drilling operation so that the natural hydraulic properties are restored; and (2) to improve the basic physical characteristics of the aquifer near the borehole so that water will flow more freely to a well. Well development is confined mainly to a zone immediately adjacent to the well, where the formation materials have been disturbed or adversely affected by well construction procedures.

Well development may involve surging, swabbing, bailing, constant flow pumping, or a combination of one or more methods. Constant flow pumping is the most common development method that will be used on the Hanford Site. This method typically uses either a turbine pump or a submersible electric pump to remove water from the well.

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[2]Odex is a registered trademark of Atlas Copco and Aktiebolag, Stockholm, Sweden.

Well development is usually conducted in two stages. Stage 1 is done after the sand pack has been set and prior to installation of the annular seal. Additional filter sand is added to the annulus as the sand settles to get the sand pack thickness required by the well design criteria. By removing water from the borehole, fine particles are removed and sand pack settling and installation is achieved. Stage 2 development, which is the more extensive development phase, consists of removing water and sediment to clean the well and attain a specified nephelometric turbidity unit value (the amount of suspended solids in well effluent). All purgewater is handled per WHC-CM-7-7 (EII 10.3).

2.7 AQUIFER TESTING

Aquifer testing refers to physical testing methods to determine the hydrologic characteristics of confined or unconfined aquifers. Slug and constant discharge pumping test methods are addressed in WHC-CM-7-7 (EII 10.1). The first method is by displacement of water in a well by the use of a rod (slugging rod) and the monitoring of the water level in the well during recovery (slug test). The other method involves the constant discharge of water from a well by pumping and the monitoring of water levels during water level drawdown (and later recovery) when the pumping stops (pumping and recovery test). Water level monitoring during a pumping and recovery test may be limited to the well pumped, but should include one on more nearby observation wells that are not pumped.

Downhole testing equipment and components are decontaminated to preclude cross-contamination between wells. Decontamination occurs before and after each testing activity or before testing at a new location. Decontamination of downhole equipment will be conducted in accordance with the guidelines provided in WHC-CM-7-7 (EII 5.4). The purgewater from the well will be contained or disposed of in accordance with WHC-CM-7-7 (EII 10.3).

2.8 GROUNDWATER SAMPLING

The general requirements applicable to all groundwater sampling activities are established in WHC-CM-7-7 (EII 5.8); specific methods for performing various individual sampling techniques are also provided in EII 5.8. All sampling activities will comply with the RWP, HWOP, or Job Safety Analysis (JSA) requirements for access control, monitoring of radiation and environmental hazards, and personal protective equipment. The purgewater from the well will be contained or disposed of as required by WHC-CM-7-7 (EII 10.3). All containment or disposal of purgewater from the well site will be documented in the field logbook and may also be recorded in the field activity report.

Nonroutine releases of purgewater are reported and responded to as specified in WHC-CM-7-5, *Environmental Compliance Manual* (Part B). Spills and or leaks that are not classified as nonroutine releases are contained, analyzed, and disposed of in accordance with WHC-CM-7-7 (EII 4.2).

2.9 DISPOSAL OF PURGEWATER

The management of purgewater that is generated by the development, remediation, maintenance, aquifer testing, and sampling of the Hanford Site groundwater monitoring wells is provided in WHC-CM-7-7 (EII 10.3). The application covers activities from the time of purgewater generation to its disposal in either a storage facility or soil column. The management of purgewater is based on the regulations provided in DOE-RL 1990 and was approved by the U.S. Environmental Protection Agency (EPA), the Washington State Department of Ecology (Ecology), and the U.S. Department of Energy, Richland Field Office (RL). That document states that purgewater from the Hanford Site will be collected and stored for future treatment when the concentration of radiological and chemical constituents exceed the collection criteria listed in Table 1 of that document (DOE-RL 1990). An updated listing of Hanford Site wells requiring purgewater collection is provided also in Table 4 (DOE-RL 1990). The collection criteria provide for an acceptable level of protection to public health and the environment.

2.10 WELL REMEDIATION

The responsibilities and job control methods for initiation, direction and documentation of remediation activities for existing groundwater wells on the Hanford Site are specified in WHC-CM-7-7 (EII 8.3). Remediation of individual groundwater wells may be necessary to allow the well to be used for purposes other than intended when drilled, preclude migration of contaminants into or between aquifers, or allow continued use of the well for its intended purpose. Remediation activities may include any or all of the following:

- Installing and/or replacing reinforced concrete surface pads
- Installing protective posts around the well heads
- Installing and/or replacing protective well head caps
- Installing an annular surface seal of grout between the well casing and borehole wall
- Installing new casing or perforating existing casing
- Adjusting and maintaining sampling pumps.

2.11 ABANDONMENT/DECOMMISSIONING

Abandonment of groundwater wells will be performed in accordance with WHC-CM-7-7 (EII 6.10). The requirements in EII 6.10 implement the standards of WAC 173-160 to provide for the protection of public health, the environment, and aquifer water quality. Individual groundwater wells may be abandoned and/or decommissioned to prevent the following from occurring:

1. Prevent the well from being used for purposes other than intended
2. Preclude migration of contaminants into or between aquifers

3. Withdraw the well from use when the following apply to the well:

   a. Not suitable for rehabilitation or has failed structurally
   b. Not chemically compatible with its environment
   c. No longer required for any documented use
   d. Cannot meet data quality objectives for the well.

Wells will be abandoned to meet Washington State regulations for well abandonment and Hanford Site requirements for public health and environmental protection and waste minimization.

2.12 POTENTIAL ENERGIES

Potential energies were evaluated to determine the level of impact, if any, on the intrinsic hazards introduced in Section 2.1. The potential energies are listed below:

- Advancement of the drill bit in the borehole
- Compressed air employed in the Odex method
- Ignition of combustible gas originating from the borehole
- Work done by the pump to extract purgewater
- Energy imparted to contaminant particulates by wind.

Advancement of the drill bit through the vadose zone does not provide a mechanism for dispersement of potentially contaminated soils except when the cuttings are removed from the borehole. The removal of drill cuttings is performed in accordance with WHC-CM-7-7 (EII 4.2).

The use of compressed air as a circulation media in the Odex drill method does provide a means for lofting potentially contaminated particulate into the air. A containment system (TORIT[3] fan-filter combination) is currently employed with the Odex method and has proven to be an effective method for controlling fugitive dust. Nevertheless, the Odex method is now used only where there are no known contaminants in the soils. Consequently, compressed air is not an issue because there are no hazardous materials present. In the event that the Odex method is used at contaminated sites in the future, the compressed air and containment system must be reevaluated.

Low levels of combustible gases may be encountered in the borehole during drilling operations, thus presenting a potential flammable hazard if cutting or welding on the well casing is performed. Many groundwater wells have been installed on the Hanford Site to date. Results from past drilling experience indicate that the advancement of the drill bit through the vadose zone has no significant impact on combustible gases.

Work done by the pump in conducting purgewater from the aquifer to the surface does not increase the inherent hazard of contaminated purgewater (discussed in Section 4.1).

[3]TORIT is a registered trademark of TORIT Manufacturing Company, St. Paul, Minnesota.

Wind has a potential for unsettling and spreading potentially contaminated dust. Given the unstable air conditions in the field, the small fraction of respirable size particles, and the characteristic low level contamination, an airborne radionuclide hazard to the site worker is unlikely. A conservative worst case accident scenario involving contaminated drill cuttings was analyzed in Lehrschall 1992. A discussion of the accident scenario is covered in Section 4.0 of this document.

3.0 SITE DESCRIPTIONS

3.1 PHYSICAL SETTING

The Hanford Site is located in south-central Washington State, approximately 273 km (170 mi) southeast of Seattle and 201 km (125 mi) southwest of Spokane (Figure 5). The average annual precipitation at the Hanford Site is 16.1 cm (6.3 in.). Most of the precipitation takes place during the winter, with nearly half of the annual amount occurring from November through February (Delaney et al. 1991). Average monthly temperatures at the Hanford Site range from 1.5° C (29° F) in January to 24.7° C (76° F) in July (PNL 1990).

3.2 METEOROLOGY

Prevailing wind directions are generally from the northwest throughout the year. Winds from the northwest quadrant occur most often during the winter and summer. During the spring and fall, the frequency of southwesterly winds increases. Monthly average wind speeds are generally lowest during the winter, averaging 10 to 11 km/hour (6.2 to 6.8 mi/hour). Monthly average wind speeds that peak above average are usually associated with southwesterly winds (PNL 1990).

3.3 GEOLOGY

The Hanford Site lies near the center of the Pasco Basin, a sub-basin of the Columbia Basin. Bedrock in the Pasco Basin is the Columbia River Basalt Group, which consists of numerous basalt flows and interbedded sediments with maximum accumulations of more than 3,048 m (10,000 ft).

Overlying the Columbia River Basalt Group at the Hanford Site are unconsolidated deposits ranging in thickness from 0 to 182.88 m (0 to 600 ft). The major unconsolidated deposits include the Ringold Formation, a thick fluvial/flood plain sequence of gravel, sands, silts and clays, and the Hanford Site formation, a glacial fluvial deposit of coarse-grained gravel and sand. A generalized geologic cross section of the Hanford Site is shown in Figure 6.

Figure 5. Orientation of the Hanford Site.

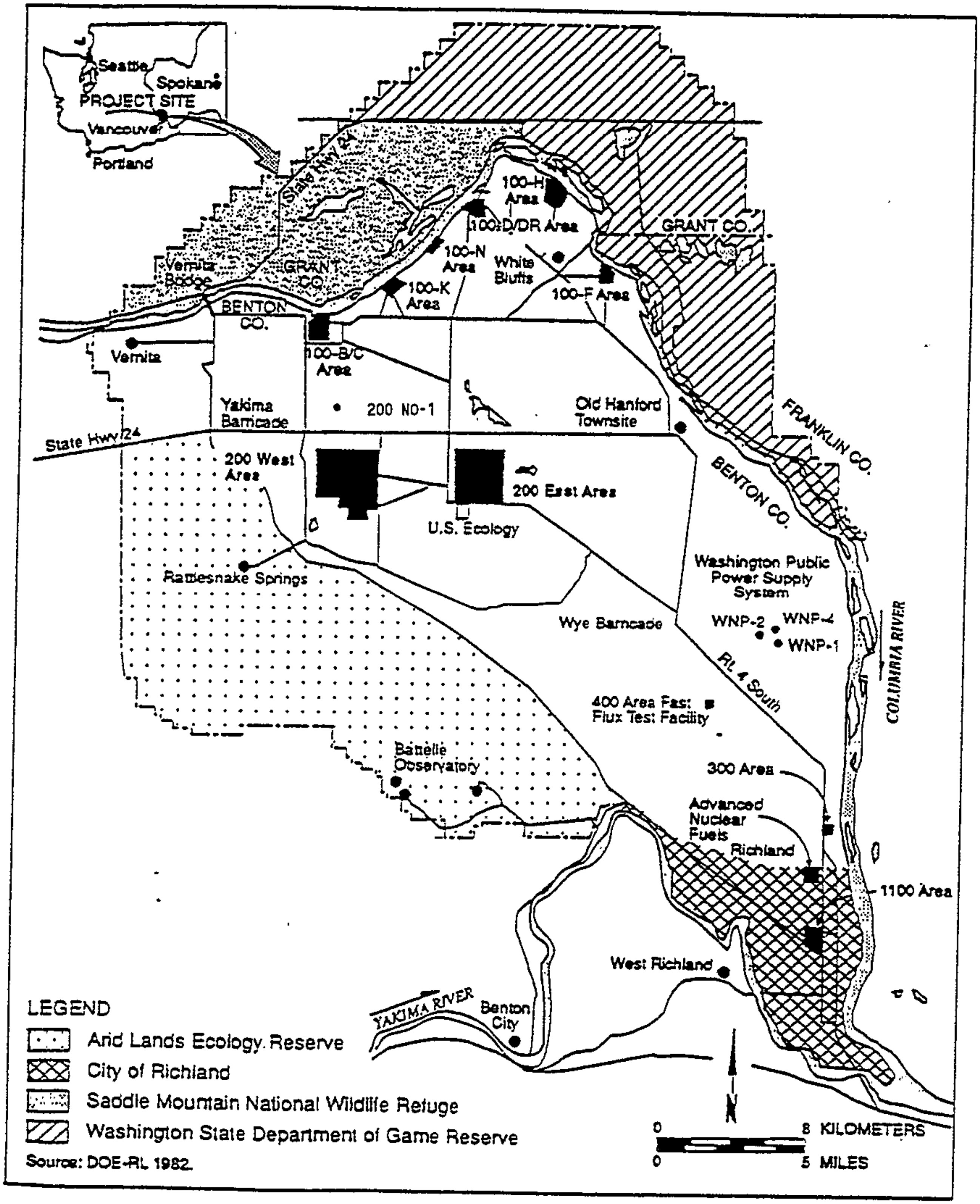
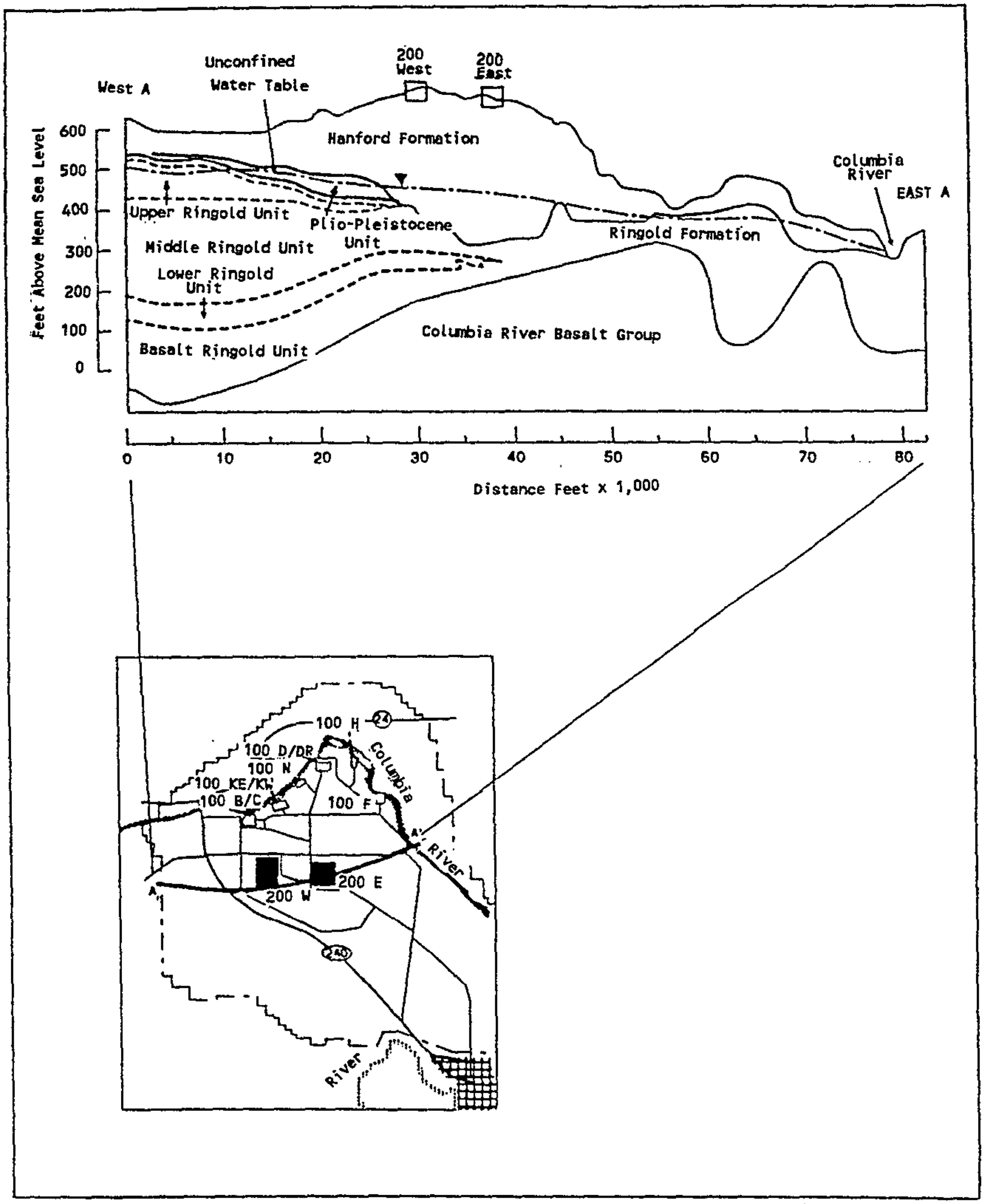


Figure 6. Generalized Cross Section of the Hanford Site.



Source: Liikala et al. 1988

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3.4 HYDROGEOLOGY

Groundwater at the Hanford Site occurs under both confined and unconfined conditions. The unconfined aquifer is contained primarily within sedimentary deposits of the Ringold and Hanford Site formations. The depth to groundwater beneath the plateau area of the Hanford Site is generally 61 (200 ft) to 91 m (300 ft). North and east of Gable Butte in the 100 Areas, however, the water table is shallower and lies within the Hanford Site formation at depths as shallow as 6.7 m (22 ft) from ground surface (Liikala et al. 1988). The base of the unconfined aquifer is defined either by the clay zones of the lower Ringold Formation or by the top of Columbia River Basalts where the lower Ringold Formation is absent. A map of recent water table elevations at the Hanford Site can be seen in Figure 7.

Groundwater generally moves eastward across the Hanford Site and north to northeast beneath the 100 Areas towards the Columbia River, which receives groundwater discharge from the unconfined aquifer along much of its length. The general eastward flow is interrupted by groundwater mounds that occur near the 200 Areas as a result of artificial recharge from onsite disposal of process water.

The unconfined aquifer is naturally recharged by precipitation, infiltration from higher elevations, leakage from the confined aquifer, and influent reaches of the Yakima and Columbia Rivers. Most of this recharge originates from higher elevations in Cold Creek and Dry Creek Valleys, immediately west of the Hanford Site.

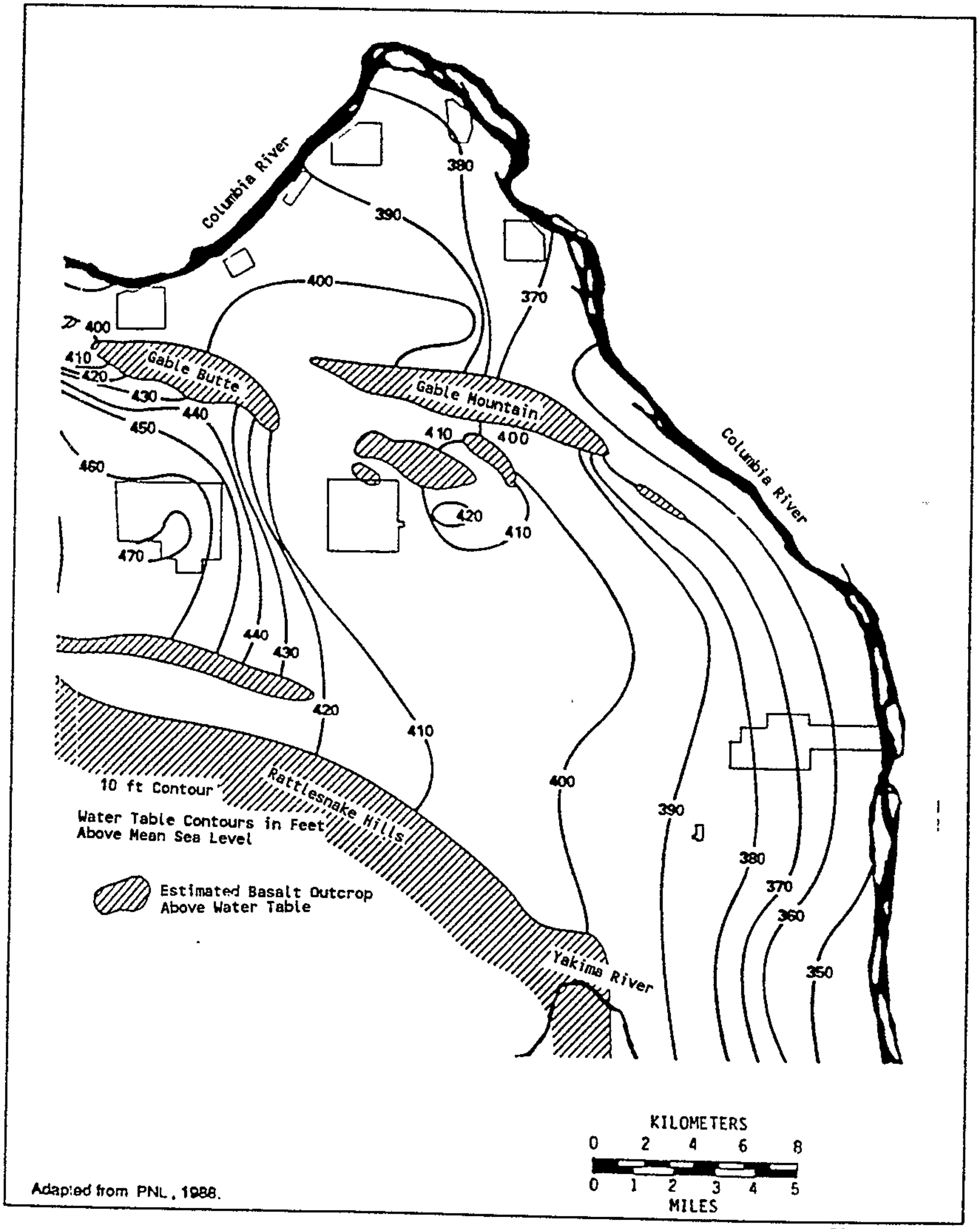
The confined aquifers of the regional groundwater flow system are contained in the rubbley interflow zones within the basalts and in sedimentary units interbedded within the Columbia River Basalt Group.

4.0 HAZARDS ASSESSMENT

4.1 DISCUSSION AND SUMMARY OF POTENTIAL HAZARDS

The potential exposure pathways for hazardous substances encountered during the groundwater drilling and sampling activities may consist of inhalation, ingestion, or absorption. The hazardous materials consist of potentially contaminated drill cuttings, contaminated groundwater, and potential hazardous concentrations of volatile organic compounds. Section 2.1 shows that contamination levels encountered during groundwater well drilling activities are relatively low. Because of the low contamination levels, air concentrations of suspended contaminants at the drill site are anticipated to be orders of magnitude below the derived air concentrations (DAC) for the potential radionuclides in the drill cuttings. Maximum radiological contamination is anticipated to be less than 10,000 dpm beta\gamma per probe area measured with field instruments.

Figure 7. Recent (1987) Water Table Elevations at the Hanford Site.



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Inhalation of dust generated from the drilling activity, though unlikely, is the principle pathway by which a worker might be internally exposed to radionuclides. For estimating a worst case dose consequence for groundwater well drilling, a 10 mR/hour contact reading on the drive barrel is assumed and the contents dropped to the ground. The estimated dose consequences to the three receptors are then 0.14 mrem to the site worker, 0.062 mrem to the onsite, and 4.6 E-5 mrem to the offsite individual. The results are summarized and compared to the low hazard class limits in Table 2 below.

Table 2. Dose Consequences and Corresponding Limits.

Receptor	Dose consequence (rem)	Hazard class limit (rem)
Site worker	1.4 E-4	25
Onsite worker	6.2 E-5	5
Offsite individual	4.6 E-8	0.5

A potential exists for organic vapors to collect at the well head as a result of drilling through an underground plume (such as the CCl_4 plume in the 200 West Area) and into contaminated groundwater. Air concentrations at the well head have been known to exceed the 2 p/m 8-hour time weighted average (TWA) for CCl_4 on occasion. There are no hazard class criteria for toxicological consequences to the site worker. A general use classification for activities where the consequence to an onsite individual is <0.1 immediately dangerous to life or health (IDLH) is provided in WHC-CM-6-32, *Safety Analysis and Regulation Work Procedures*. Carbon tetrachloride has an IDLH of 300 p/m; one tenth of the IDLH is 30 p/m. Concentrations of this magnitude are highly unlikely to the onsite receptor [generally located at 100 m (330 ft)]. The *Code of Federal Regulations* sets the acceptable ceiling limit at 25 p/m for CCl_4 (29 CFR 1910, Table Z-2). The Site Safety Officer and Field Team Leader are responsible for providing the proper respirator protection for personnel at the drill site if breathing zone air concentrations exceed occupational limits.

Skin contamination is a minor concern to the site worker performing the drilling and sampling activities where drill cuttings and groundwater are found to be contaminated. The EIIs listed in Table 1, along with the JSA, RWP, and HWOP provide the appropriate procedures and protective clothing requirements for preventing skin contaminations.

The contaminants of concern for the Hanford Site groundwater vary somewhat depending on the location of the monitoring well installation. Table 3 provides a listing of the contaminants of concern in groundwater at each area with the corresponding concentrations and the collection limits that determine whether the purgewater is collected and stored or simply discharged at a convenient distance away from the well site. According to DOE-RL 1990 (Section 3.1.1), purgewater collection criteria is based on 10 times the MCL for drinking water, or 10 times the EPA's "Chronic Freshwater Toxicity Levels," or 10 times the practical quantitation limits provided in the *Test Method for Evaluating Solid Waste--Physical/Chemical Methods* (EPA 1986) with the application of the most restrictive criteria for designation of purgewater requiring collection. The radionuclide standards are based on 10 times the MCLs referenced in 40 CFR 141 [see also 40 CFR 141.16(b)] except for uranium and plutonium standards that are based on 10 times 1/25th of the derived concentration guides as defined in DOE Order 5400.5 (DOE 1990). Tritium is not included in purgewater determinations because effective treatment technology has not been demonstrated. Disposal to the soil is a less hazardous pathway to biota than storing tritium contaminated water above ground that would involve a larger airborne pathway (DOE-RL 1990).

Table 3 indicates that some of the contaminants exceed the collection criteria. These limits are conservative in regard to public health and safety and do not represent acute exposure limits. The purgewater management document (DOE-RL 1990) and WHC-CM-7-7 (EII 10.3) are adequate for providing the necessary controls for generating and disposing of purgewater. The hazard associated with the purgewater is an ALARA issue and represents only a minor concern to the site worker. There are no impacts to the onsite worker or the public.

A safety assessment was performed for the purgewater storage facility (Erb 1991) that is located east of the 200 East Area fence line at the Hanford Site. Loss of containment due to a severe seismic event where 5,000,000 gal is released was the bounding postulated release. It was concluded in the assessment that loss of containment may result in exceeding environmental discharge limits to the groundwater but doses to onsite or offsite receptors would be negligible. The CCl_4 present in the purgewater was determined to pose no threat to onsite or offsite personnel. Doses to operations personnel based on a tritium intake (tritium is the major radiological component) was conservatively estimated at one mrem. The assessment concluded that CCl_4 vapor could possibly exceed the threshold limit value TWA but based on a noncontinuous exposure, the risk to the onsite worker is negligible.

4.2 DISMISSAL OF NEGLIGIBLE HAZARDS

4.2.1 CRITICALITY

A criticality event was dismissed based upon the lack of sufficient fissionable material at locations where groundwater monitoring wells are installed.

4.2.2 RADON GAS

Radon gas emissions were evaluated in the assessment for drilling in relatively high contaminated soils and were found to be negligible (Lehrschall 1992).

Table 3. Contaminants of Concern and Collection Criteria.

Area	Contaminant	Concentration	Collection Criteria
100-BC	Strontium-90	50 pCi/L	80 pCi/L
--	Cesium-137	20 pCi/L	2,000 pCi/L
--	Chromium	0.05 mg/L	0.11 mg/L
--	Nitrate	50 mg/L	450 mg/L
100-K	Nitrate	60 mg/L	450 mg/L
--	Tritium	500,000 pCi/L	N/A
--	Chromium	0.12 mg/L	0.11 mg/L
100-N	Strontium-90	10,000 pCi/L	80 pCi/L
--	Tritium	100,000 pCi/L	N/A
100-D	Strontium-90	40 pCi/L	80 pCi/L
--	Tritium	30,000 pCi/L	N/A
--	Chromium	0.5 mg/L	0.11 mg/L
--	Nitrate	100 mg/L	450 mg/L
100-H	Nitrate	200 mg/L	450 mg/L
--	Chromium	0.3 mg/L	0.11 mg/L
--	Technetium-99	2,000 pCi/L	9,000 pCi/L
--	Uranium	100 pCi/L	400 pCi/L
100-F	Strontium-90	200 pCi/L	80 pCi/L
--	Uranium	80 pCi/L	400 pCi/L
--	Nitrate	120 mg/L	450 mg/L
300	Uranium	270 pCi/L	400 pCi/L
--	Gross beta	40 pCi/L	500 pCi/L
--	Tetrachloroethane 1,2 Dichloroethene	0.02 mg/L 0.15 mg/L	8.4 mg/L
--	Copper	0.04 mg/L	0.12 mg/L
1100	Trichloroethylene	0.06 mg/L	0.05 mg/L
--	Gross Beta	30 pCi/L	500 pCi/L
--	Nitrate	200 mg/L	450 mg/L
200 East	Nitrate	300 mg/L	450 mg/L
--	Technetium-99	10,000 pCi/L	9,000 pCi/L
--	Cyanide	500 µg/L	0.052 mg/L
--	Cobalt-60	500 pCi/L	1,000 pCi/L
--	Strontium-90	5,000 pCi/L	80 pCi/L
--	Cesium-137	2,000 pCi/L	2,000 pCi/L
--	Plutonium	70 pCi/L	12 pCi/L
--	Iodine-129	10 pCi/L	30 pCi/L
--	Tritium	2,000,000 pCi/L	N/A
200 West	Carbon tetrachloride	1.0 mg/L	0.05 mg/L
--	Chloroform	0.20 mg/L	1.0 mg/L
--	Cyanide	0.050 mg/L	0.052 mg/L
--	Chromium	0.050 mg/L	0.11 mg/L
--	Technetium-99	10,000 pCi/L	9,000 pCi/L
--	Uranium	5,000 pCi/L	400 pCi/L
--	Nitrate	500 mg/L	450 mg/L
--	Tritium	200,000 pCi/L	N/A
--	Iodine-129	10 pCi/L	30 pCi/L
600	Tritium	200,000 pCi/L	N/A

N/A = Not applicable

4.2.3 NATURAL PHENOMENA

Natural phenomena events such as floods, runoff, lightning, and earthquakes would not have any appreciable impact as far as increasing the hazardous material consequences considered in this assessment. A natural phenomenon like lightning may be a hazard in and of itself and therefore may have an influence on the type of weather conditions allowed when drilling. High wind events could potentially contribute to the spread of minor soil contamination from well drilling activities. Compliance with the procedures contained in WHC-CM-7-7 will assure that contamination spreads do not occur.

4.3 CONCLUSION

This assessment concludes that groundwater well drilling activities performed in areas that exceed the criteria specified in WHC-CM-4-10 (Table 11-1) are classified as low hazard activities in accordance with the policy requirements of WHC-CM-4-46 and the work procedures of WHC-CM-6-32. Activities performed in areas that are below the surface radioactivity guides specified in WHC-CM-4-10 (Table 11-1) are classed as general use and are excluded from the safety analysis and review requirements of DOE 1986 and do not require an OSL. This safety assessment satisfies the requirements of WHC-CM-4-46 and DOE 1986.

An OSL addressing the maximum field dose rates on drill cuttings is provided in Section 5.0. The OSL was prepared to assure the integrity of the safety basis established in this assessment.

Potentially combustible gases may be encountered that present a potential fire hazard to workers if accidentally ignited. An OSL was prepared that puts a limit on the levels of combustible gases in the borehole when spark producing activities are performed.

5.0 OPERATIONAL SAFETY LIMITS AND PRUDENT ACTIONS

An OSL is an auditable limit established within WHC for the safe operation of a nonreactor nuclear facility or activity. The RL has a policy that at least one limit shall be established to assure the facility is operated or activity is performed safely and within the bounds of the safety assessment. Site or activity specific RWPs, HWOPs, or other safety documents shall implement the appropriate OSL(s). The limits may be more stringently specified commensurate with the site conditions but shall not exceed the bounds of the OSL.

Two OSLs were prepared to ensure the integrity of the safety basis of this assessment. The first OSL sets a limit of 10 mR/hour on the drill cuttings at wells drilled or remediated in areas where the criteria of WHC-CM-4-10 (Section 11) is exceeded. The second OSL limits spark producing activities when combustible gas levels >10% of the LEL are detected in the borehole.

Other groundwater activities such as development, sampling, and abandonment of groundwater monitoring wells will be excluded from the OSL requirement. Hazards and risks are such that existing procedures contained in WHC-CM-7-7 are sufficient for providing adequate controls.

5.1 OPERATIONAL SAFETY LIMITS

<u>OPERATIONAL SAFETY LIMIT 1 - CONTROLLING RADIOACTIVITY ENCOUNTERED DURING ACTIVITIES</u>

1.1 TITLE: Limit the Potential Radioactivity of the Soils Removed from the Borehole.

1.2 APPLICABILITY This OSL applies to the drilling or remediation of groundwater wells where the criteria specified in WHC-CM-4-10 (Section 11) is exceeded.

1.3 OBJECTIVE: To provide a measure of control on the radioactivity encountered during drilling and remediation activities.

1.4 REQUIREMENT: Dose rates on the drill cuttings removed from the bore hole shall not exceed 10 mR/hour on contact.

1.5 SURVEILLANCE: Drill cuttings generated from well drilling or remediation shall be monitored at a frequency that is to be determined on a case-by-case basis. The field team leader, in conjunction with the Site Safety Officer, and health physics technician, will increase the frequency of the surveillance if the potential of encountering contamination increases. Compliance with the requirement in 1.3 above shall be documented in an auditable log or Field Activity Report.

1.6 RECOVERY: In the event that the OSL is exceeded, the work shall stop. The source of the unanticipated contamination levels shall be evaluated and a recovery plan prepared. Safety Assurance will provide the oversight approval prior to implementation of the recovery plan.

1.7 BASIS: The limit provides assurance that the integrity of the safety basis established in this assessment is maintained. Existing and approved work procedures would accept higher limits based on occupational safety. The recovery work plan, if required, will assure that if unanticipated conditions (radiological) are encountered the conditions will be assessed to minimize the potential of unknown risks.

OPERATIONAL SAFETY LIMIT 2 - LIMITS FOR SPARK PRODUCING ACTIVITIES

2.1 TITLE: Limits for spark producing activities (i.e., welding, cutting, and grinding) when combustible gases are detected.

2.2 APPLICABILITY: This OSL applies to all spark producing activities when combustible gases ≥10% of the LEL are detected in the borehole.

2.3 OBJECTIVE: To assure that combustible gas levels are reduced below 10% of the LEL before any spark producing activity is performed.

2.4 REQUIREMENTS: -

a. Where combustible gas levels ≥10% of the LEL are detected (by a portable combustible gas analyzer or similar detector), the Site Safety Officer shall increase the monitoring frequency of the borehole in accordance with applicable work procedures.

b. No spark producing activity (grinding, welding, or cutting) will be allowed when combustible gas levels ≥10% of the LEL are detected in the borehole. If it is necessary to grind, weld, or cut when combustible gas levels ≥10% of the LEL are detected, actions required by the work procedures shall be implemented (e.g., installation of bladder seal, purging of borehole, etc) to reduce the combustible gas levels below 10% of the LEL before work is performed.

2.5 SURVEILLANCE: The Site Safety Officer is responsible for monitoring of the borehole to assure that combustible gas levels are <10% of the LEL prior to any spark producing activity. Compliance with the requirements of this OSL shall be documented in an auditable log or Field Activity Report.

2.6 RECOVERY: In the event that combustible gas levels are found to be ≥10% of the LEL, approved engineering controls (e.g., purging, bladder seal, etc.) shall be implemented according to the work procedures to reduce the levels prior to any spark producing activity.

2.7 BASIS: This OSL is conservatively based on the potential for combustible gases to be ignited from sparks generated from cutting, welding, and/or grinding at the borehole.

5.2 PRUDENT ACTIONS

Prudent actions are commitments to ALARA goals and are generally good engineering work practices. Credit is given to the EIIs in WHC-CM-7-7, the HWOPs, and RWPs for providing safe work practices for performing the groundwater well drilling and support activities. Two specific prudent actions are identified below.

Function 1 - Minimize exposures to hazardous volatile gases (e.g., CCl_4).

Prudent Action 1 - If drilling in areas where air concentrations could approach or exceed occupational limits for hazardous vapors, appropriate protection measures should be taken to minimize personnel exposures.

Function 2 - Minimize potential for skin contaminations.

Prudent Action 2 - Don personnel protective clothing appropriate for handling potentially contaminated groundwater (rubber gloves, gauntlets, etc.).

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- EII 4.2, "Interim Control of Unknown, Suspected Hazardous and Mixed, and Radioactive Waste."
- EII 4.3, "Control of CERCLA and Other Past Practice Investigation Derived Waste."
- EII 4.4, "Control and Storage of Radioactive Materials and Equipment."
- EII 5.2, "Soil and Sediment Sampling."
- EII 5.4, "Field Decontamination of Drilling, Well Development and Sampling Equipment."
- EII 5.8, "Groundwater Sampling."
- EII 5.11, "Sample Packaging and Shipping."
- EII 6.4, "Resource Protection Well Services."
- EII 6.6, "Resource Protection Well Characterization and Evaluation."
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- EII 6.8, "Well Completion."
- EII 6.10, "Abandoning/Decommissioning Ground Water Wells."
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N. R. Kerr	H4-67	X		
J. A. Locklair (2)	H4-67	2		
D. J. Moak	N3-05	X		
W. H. Price	N3-05			
A. R. Schade	H4-60			
K. A. Smith	N1-06	X		
W. R. Thackaberry	H4-16	X		
D. S. Takasumi	L4-93	X		
M. A. Tredway	R3-54	X		
B. A. Williams	H6-06	X		
T. M. Wintczak	H6-27	X		
J. J. Zimmer	N1-83	X		
Central Files (2 + original)	L8-04	X 2		
Dockett Files (2)	H5-36	X 2		
ERSS File (3)	H4-67	X 3		
EDMC (2)	H6-08	X 2		